Topic:Tissue

Definitions:

1. *Differentiation*: It is the process of qualitative changes in the cells to perform different functions in living organisms.
2. *Primary growth*: It is the increase in length that results from cell division and differentiation of an apical meristem.
3. *Secondary growth*: It is the increase in width or girth that results from cell division and differentiation of lateral meristem.
4. *Vascualar bundles*: It is the conducting tissue of a plant that is formed of xylem and phloem.
5. *Monocot*:- These are the plants whose seeds have only one cotyledon. Example, corn seeds, Rice, garlic, etc.
6. *Dicot*:-These are the plants whose seeds have two cotyledons. Eg. Beans, peaches, etc.
7. *Sarcomere*:- The smallest functional unit of myofibril which occurs as repeated units along the length of myofibrils.
8. *Myofibril*: It is a muscle fibre which is basic rod like unit of a muscle.
9. *Nerve impulse*: It is a self-propagated electro-chemical current that travels from one neuron to another for the passage of message.
10. *Synapses*: It is the functional junction between neurons.

Tissue:

A tissue may be defined as a group or cluster or collection of similar or dissimilar cells that perform or help to perform a common function and have a common origin.

The word 'tissue' is derived from a French word 'Texo' meaning 'to weave'. It was first given by a French Biologist namely 'Bichard'. Study of tissues is called 'Histology'.

Types of Tissues: There are two types of tissues:

1. Plant Tissues.
2. Animal Tissues.

1. *Plant Tissues*:

Plant tissues are divided into two types:

i) Meristematic Tissues ii) Permanent Tissues

i) *Meristematic Tissues*:-

They are simply called Meristems. They are formed by a cluster of cells. They have the ability to divide continuously. They never stop dividing.

When they stop dividing, they result in the formation of permanent tissues. When they divide continuously, they help a plant to increase in length as well as in girth. They are responsible for both primary growth as well as the secondary growth of a plant.

Characteristics of meristematic tissues:

1. The cells of meristematic tissues are similar in structure and have thin and elastic cell walls made of cellulose.
2. The meristematic cells may be oval, rounded, polygonal or rectangular in shape.
3. They are compactly arranged without intracellular spaces between them.
4. Each cell contains dense and abundant cytoplasm and a large prominent nucleus.
5. It contains few small vacuoles or no vacuoles at all.
6. New cells are produced, take up a specific function and lose the ability to divide and thus form permanent tissue.

Occurrence:

Depending upon the occurrence and position in the plant body, meristematic tissue is divided into three types:

i) Apical meristem.
ii) Lateral meristem.
iii) Intercalary meristem.

i) *Apical meristem*:-

This meristem is located at the growing apices of main and lateral roots, stems and leaves. These cells are responsible for linear growth of an organ. It thus, results in the increase in the length of plant which is called primary growth.

ii) *Lateral Meristem*:

This meristem occurs on sides almost parallel to the axis of roots, stems and its branches.

It brings about an increase in the width or girth of the plant which is called as secondary growth. Lateral meristem is of two types.

1. Cork cambium
2. Vascular cambium

1. Cork cambium: The lateral meristem which occurs beneath the bark of a plant is called cork cambium.

2. Vascular cambium: The lateral meristem which occurs in vascular bundles of dicots is called vascular cambium.

iii) Intercalary meristem:-

This meristem is located at the base of leaves or at the base of node and internode. It is also present in the regions of permanent tissues. It is responsible for growth in length.

3. ***Permanent Tissues***:

It may be defined as a group or collection of living or dead cells formed by meristematic tissues and have lost their ability to divide and are permanently placed at fixed positions in plant body.

Characteristics Of Permanent Tissues:

1. They constitute a major portion of plant body.
2. Their cells have lost the power of division.
3. Cells are mature, thin or thick, living or dead.
4. These may be oval, rounded, polygonal, elongated, etc.
5. They have intercellular spaces.
6. They have vacuolated cytoplasm.

Simple Permanent Tissue:-

It is a type of permanent tissue which is composed of similar type of cells. These cells are structurally and functionally similar. On the basis of nature of cells, simple permanent tissues are divided into three types:

1. Parenchyma
2. Collenchyma
3. Sclerenchyma

1. *Parenchyma*:-

It is derived from two words 'para' meaning 'besides' and 'enchyma' meaning 'to pour' or 'enchein' meaning 'in fillings'.

General characters:

1. It is most simple and unspecialized primitive tissue.
2. It mainly consists of thin walled cells which have intercellular spaces between them.
3. Cell wall is made of cellulose or calcium pectate.
4. Each cell has a prominent nucleus and vacuolated cytoplasm.
5. Cells are living and perform metabolic activities/ processes.
6. It forms the basic packing tissue of plant body and is the most abundant tissue of the plants.

Shape: Cells may be isodiametric, spherical, cylindrical, rectangular, stellate or long spindle, etc.

Distribution: Parenchyma is widely distributed in various plant organs i.e. roots, stems, leaves, flowers and fruits. They are found in endosperm of seeds, xylem and phloem. Types

Parenchyma is of three types:

1. Storage parenchyma
2. Arenchyma
3. Chlorenchyma

1. Storage parenchyma: It is that type of parenchyma in which cells enlarge and store nutrients and water e.g. starch in the parenchyma of potato.

2. *Arenchyma*: It is that type of parenchyma that has large air cavities to give buoyancy to the plant e.g. aquatic plants like hydrilla.

3. *Chlorenchyma:* It's that type of parenchyma that contains chloroplasts and thus performs photosynthesis e.g. leaves.

Functions Of Parenchyma

1. The main function of parenchyma is storage of food e.g. starch in parenchyma of potato.
2. In fleshy stems and leaves, parenchyma cells serve as water storage tissue e.g. opuntia (cactus)
3. It forms the framework of all the plant organs and tissues by providing rigidity to the plant and thus help to maintain shape and firmness of plant body.
4. It stores waste materials of the plants such as latex, resins, gums, etc.
5. The: intercellular air spaces of parenchyma cells allow gaseous exchange.
6. It provides buoyancy in aquatic plants.
7. If chloroplast is present in parenchyma cells, it performs photosynthesis.
8. It serves as the packing tissue in between the other tissues.
9. It provides mechanical strength to the plants due to its compact arrangement.

***Collenchyma*:-**

It's derived from two words 'colla' and 'enchyma'. Colla means glue and enchyma means - to pour.

General characters

1. It is a living tissue.

2. Cells are thin walled but possess thickenings of cellulose or pectic substances at the corners where a number of cells join together.
3. Cells are compact.
4. Intercellular spaces are absent.
5. It provides flexibility to soft ariel parts of plants so that they can bend without breaking.
6. It may contain a few chloroplasts.

Shape: Collenchyma cells are usually elongated with oblique end walls. In transverse section they appear circular, oval or polygonal.

Distribution: Collenchyma occurs in dicot stem and leaves. It's mainly absent in monocots and in roots.

Functions Of *Collenchyma*

1. It provides mechanical support, protection and elasticity to the plant organs.
2. It manufactures sugar and may store it as starch.
3. It is present at the margins of some leaves and resists tearing effect of wind.
4. It allows easy bending in various parts of the plants without breaking it.

Sclerenchyma:-

It is derived from two words; sclern from sclerous which means hard and enchyma which means in fillings.

General characters:

1. It consists of thick walled dead cells.
2. Those cells have hard and extremely thick cell wall due to uniform deposition of lignin (a complex organic molecule composed of phenyl propanoid units associated with cellulose).
3. Lignin deposition is so thick that the cell wall becomes strong, rigid and impermeable to water.
4. The cell lumen becomes very narrower rarely absent.'
5. Cells are closely packed without intercellular spaces.
6. Cells are cemented with the help of middle lamella [a wall that lies between the adjacent cells].

Shape:- Cells appear as hexagonal net in transverse section.

Types: Sclerenchyma is of two types:

1. Fibres
2. Sclereids

1. *Fibres*:-

These are long, elongated cells with pointed ends. These cells vary in length from 1mm to 550.mm in different plants. The fibres are usually clustered into strands and look polygonal.

2. *Sclereids*:

These are short and possess extremely thick lignified walls. They vary greatly in their shape and size. They may be spherical, oval, cylindrical, dumble shaped or stellate.

Distribution: Sclerenchyma tissue mostly occurs in xylem and phloem, hard seed coats and husk of coconut.

Functions:

1. The main function of Sclerenchyma is to give mechanical support to the plants.
2. It provides a protective covering around seed and nut.
3. Sclerenchyma fibres in plants like jute, coconut etc are commercially exploited.

Complex Permanent Tissues: A complex permanent tissue may be defined as a group of more than one type of cells having a common origin and working together as a unit to perform a common function. The complex tissues are mainly concerned with the transportation of water, minerals and food materials. The important complex tissues in plants are:

1. Xylem or wood
2. Phloem or Bast

Both xylem and phloem are together called as vascular tissues or vascular bundles or conducting tissues.

1. Xylem:-

It is derived from Greek word 'xylos' which means 'wood'. It was first of all seen by a biologist Nageli in 1858.

It's a chief conducting tissue responsible for conduction of water and minerals. This tissue is composed of four kinds of cells.

1. Tracheids

2. Vessels
3. Xylem parenchyma
4. Xylem fibres

1. *Tracheids*:

These are elongated, tube like dead cells with oblique end walls. The end walls remain intact and possess pits, since tracheids do not have open ends, so water has to pass through pits. These usually appear polygonal. The walls are hard and lignified.

2. Xylem vessels or Trachea:

The cells of vessels are placed one upon the other and their end walls are either absent or possess perforations. They form long tubes or channels for conduction of water and minerals. Tracheids and vessels are meant for conduction of sap, so they are also called as tracheary elements.

3. Xylem parenchyma:

These are living parenchymatous cells present in the xylem. They help in lateral conduction of organic solutes and storage of food reserves.

4. *Xylem fibres:* These are lignified fibres present in the xylem which provide mechanical strength to the plant body.

Functions of xylem:

1. Xylem is a major conducting tissue in plants. It serves in the upward movement of water and mineral salts from roots to different parts of the plants.
2. It gives mechanical strength to the plant body.

2. Phloem (bast):-

It's derived from a Greek word 'phlois' which means inner bark. It was first of all used by Nageli in 1858. Phloem is the chief food conducting tissue of the plants. Phloem is composed of four elements.

1) Sieve tubes
2) Companion cells
3) Phloem parenchyma
4) Phloem fibres

1) Sieve tubes: These are long tubular structures composed of elongated sieve tube elements placed one above the other forming a continuous tube. The end walls of sieve tube elements are called sieve plates which are

perforated by numerous pores. Each mature sieve tube element has thin or thick cellulose wall. Cytoplasm occurs in the form of thin lining enclosing a big central vacuole. Nucleus, plastids, endoplasmic reticulum, etc are absent.

2. *Companion cells*: These are living cells which are always associated with sieve tubes. Each companion cell is living with thin cellulose walls. It possesses nucleus, mitochondria, ER, etc. The common wall between sieve tube and companion cell shows the presence of pits.

3. *Phloem parenchyma:* These are the living parenchymatous cells present in the phloem. They store food, raisins, latex, etc. These cells help in slow conduction of food especially to the sides.

4. *Phloem fibres:-* These are the dead sclerenchymatous fibres present in the phloem. They occur in sheets or cylinders. They provide mechanical strength to the plants.

Functions of phloem:

1. The main function of phloem is translocation of organic solutes from leaves to the storage organs
2. It provides mechanical support to the plant body.

Animal Tissues:

The body of animals is made up of different types of tissues which perform specific functions. On the basis of function they perform, animal tissues can be broadly classified into following types:

1. Epithelial tissue
2. Muscular tissue
3. Connective tissue
4. Nervous tissue

Epithelial tissue

General characters:

1. Epithelial tissue or epithelium is a simplest kind of animal tissue that occurs as a protective covering.
2. It consists of one or more layers of cells.
3. The cells are closely packed.
4. Intercellular spaces may or may not be present.
5. Cells are held together by intercellular junctions.
6. The epithelial tissue rests on a thin, non-cellular basement membrane, (a membrane that doesn't contain cells and consists of glyco-proteins and collagen fibres).
7. Blood and lymph vessels are absent. However, nerve cells are present.
8. The blood vessels lie in the connective tissue across the basement membrane.

Occurrence: It is found on the external surface of the body, internal organs (or viscera), lining of the cavities.

Functions:

1. It covers the body surface as an outer layer of skin.
2. It provides protection to the underlying tissues from mechanical injury, drying up, entry of germs.
3. It forms inner lining of mouth, elementary canal and other internal organs and protects these organs.
4. Epithelial line of intestines absorbs water and digested food.
5. It helps in the elimination of waste products.

6. Epithelial lining of the cavities give rise to glands that provide secretion such as mucus, etc.

Types of Epithelium:

Based on the shape of the cells, epithelial tissue is classified as follows:

1) Squamous epithelium.
2) Cuboidal epithelium
3) Columnar epithelium
4) Ciliated epithelium
5) Glandular epithelium
6) Sensory epithelium

***1. Squamous epithelium**:*

This epithelium consists of thin, flat irregular shaped cells which fit together closely. It is of two types.

a) Simple squamous epithelium
b) Stratified squamous epithelium

a) *Simple squamous epithelium:* The cells in this epithelium are extremely thin and flat and are arranged edge to edge forming a delicate lining or covering. So, it is also called as pavement epithelium.

Occurrence: It lines the blood vessels, urinary tubules and alveoli of the lungs.

b) Stratified squamous epithelium: The cells in this epithelium are arranged in many layers to prevent wear and tear.

Occurrence: It forms the epidermis of the skin. It also lines buccal cavity (mouth cavity), pharynx, oesophagus, anal canal, vagina and lower part of urethra.

Functions:

1. It provides protection to the underlying parts against injury and entry of germs.
2. It helps in excretion, gas exchange, etc.

2) *Cuboidal epithelium*: This epithelium consists of cube like cells which are about as tall as wide.

Occurrence:

1) It lines the salivary ducts, pancreatic ducts, sweat glands, etc.
2) It also covers the ovaries and lines sperm producing tubules.

Function

It helps in protection, secretion, absorption, excretion and gamete formation.

3) Columnar epithelium: This epithelium consists of tall or pillar like cells that are much taller than wide. The nuclei are generally elongated.

Occurrence

1) It lines the stomach, intestine and gallbladder.
2) It also lines mammary gland ducts and parts of urethra. *Functions*: It helps in protection, absorption and secretion.

4) Ciliated epithelium:

Structure: This epithelium consists of cuboidal or columnar cells that bear cilia on their free surfaces.

Occurrence: Cuboidal ciliated epithelium lines certain parts of urinary tubules and sperm ducts. Columnar ciliated epithelium lines nasal passage, oviducts, bronchioles and ventricles of brain.

Functions:

It helps in the movement of mucus, eggs, urine, sperms and ceribo spinal fluid.

5) Glandular epithelium:

Structure:- This epithelium consists of columnar cells modified to secrete chemicals or juices.

Occurrence: It lines the glands such as gastric glands, pancreatic glands, intestinal glands, etc.

Functions: It helps in secretion of juices and chemicals.

6) *Sensory epithelium*:

In some cases, the epithelial cells become modified to receive external stimuli. Such sensory cells have nerves so that they can perceive various stimuli.

Occurrence: It is found in nasal passage, taste buds, retina of eyes, etc.

Muscular Tissue:

Muscular tissue of the body consists of long, narrow muscle cells. These cells are elongated in structure and are therefore called as muscle fibres or myocytes. These myocytes inturn contain many chains of myofibrils. Myofibrils are composed of actin and myosin filaments repeated in units called sarcomere. This sarcomere is responsible for striated appearance of

muscle fibres. A muscle fibre may contain one or more nuclei. Muscle cells are arranged in parallel manner and contract in a definite direction which causes movement of body parts. These movements are brought about by contraction and relaxation of contractile proteins (actin and myosin) present in the muscle cells.

Types of Muscular Tissue:

There are three types of muscular tissue:

1) Striated muscles
2) Unstriated muscles
3) Cardiac muscles

Striated muscle *(skeletal muscle or voluntary muscle)*

Characteristics

1) The striated muscles form more than 80% of the mass of soft tissues in a body.
2) They are attached to bones by tendons and help in the movement of external body parts.
3) The striated muscles consist of long, narrow, cylindrical, unbranched fibres with blunt ends.
4) Each fibre is enclosed in a thin, plasma membrane called sarcolemma.
5) The cell contains many elongated, flattened nuclei located towards the sarcolemma.
6) The multi-nucleate condition of the fibres results from cell fusion.

Occurrence:

1) These are found in the body wall and the limbs.
2) They also occur in tongue, pharynx and beginning of oesophagus.

Functions:

1. They help in the movement of body parts and locomotion.
2. They also help in several voluntary movements of the body.

Q) Why are striated muscles called as skeletal, voluntary and striated muscles?

Ans. Striated muscles are called as skeletal muscles because they are

attached to bones and help in movement of body parts. They are also known as voluntary muscles because they are under our control. They are known as striated muscles because they contain dark and light bands.

Unstriated muscle:

Characteristics:

1. These are called smooth or unstriated muscles because they do not show any strips or striations across the muscle fibres.
2. Each cell is long, narrow, spindle-shaped with pointed ends and has only one nucleus situated in the centre.
3. These fibres are generally shorter than the striated muscle fibres.

Occurrence:

1. These occur within the walls of tubular, internal organs (visceral organs) except heart. e.g. Alimentary canal, Genital tract, blood vessels, etc.
2. They also occur in the iris and ciliary body of the eye and dermis of skin.

Functions:

1. Smooth muscles are called involuntary muscles.
2. Their contractions are rythmic.
3. These muscles contract slowly but can remain contracted for a long period of time.
4. Rythmic contractions of these muscles in the walls of tubular organs results in the rhythmic progressive wave of muscular contraction and relaxtion. (peristalisis).
5. These movements occur in gastro-intestinal tract and male genital tract.
6. In some organs, the smooth muscles contract throughout the organ as a single unit and produce extrusive movements as in urinary bladder, gall-bladder, ureters and uterus.

Cardiac muscles:

Characteristics:

1. The cardiac muscle consists of short, cylindrical fibres which are branched and joined to form a network.
2. Each fibre or cell contains one or two nuclei situated in the centre.
3. Intercalated discs occur between the ends of fibres.

4. The cell show light striations.
5. These are involuntary muscles.

Occurrence:

Cardiac muscles are confined to the wall of heart, pulmonary vein and superior venacava.

Functions:

These contract and relax rapidly and continuously with a rhythm.

Nervous tissue:

The nervous tissue contains densely packed nerve cells, called neurons (Greek neuron- nerve). It is present in the brain, spinal cord and nerves. The neurons are specialized for conduction of nerve impulses.

They receive stimuli from within or outside the body and conduct impulses (signals) which travel from one neuron to another. Each neuron is composed of following three parts:

i) Cyton ii) Dendrites iii) Axon

i) Cyton or cell body or soma: The cell body of neuron is called cyton or soma. It is a broad, rounded, pyriform (ear shaped) or stellate part of neuron. It has cytoplasm called neuroplasm and relatively large, spherical nucleus. It also contains nissll granules.

Function:

It receives nerve impulses from dendrites and transmits them to axon.

ii) Dendrites (singular Dendron):

It is a short, tapering, much branched protoplasmic processes stretching out from cell body.

Function:

It conducts the nerve impulses towards the cell body.

iii) *Axon*:

It is single, very long, cylindrical protoplasmic process of uniform diameter arising from cell body. At its terminal end, axon is highly branched. The terminal branches are called terminal arborizations. At their ends are swollen structures called synaptic knobs or bouton that have neuro transmitter called acetycholine.

Axon is covered with one or two sheaths (coverings). The cell membrane of axon is called axolema and its cytoplasm is called axoplasm. The single

sheath present over the axon is called neurilemma. It may have an additional insulating and protective sheath of myelin around it. It is present between neurilemma and axolemma. Axons having myelin sheaths are termed myelinated nerve fibres and those without this sheath are termed non-myelinated nerve fibres. At intervals, myelinated nerve fibres possess unmyelinated areas called nodes of ranvier.

Function: Axons carry impulses away from the cell body to another neuron.

Connective tissue:

General characters:

1. The cells of connective tissue are living.
2. These cells remain separated from each other.
3. The space between the cells is filled with non-living, soft, gel like matrix or medium.
4. Matrix may be fibrous in nature and composed of complex carbohydrates linked to proteins. The fibres present in it are:-

1. White collagen fibres.
2. Yellow elastin fibres.
3. Reticular Reticulin fibres, and complex carbohydrates present in it are GAG glucose amino glycans or muco polysaccherides.
4. Matrix may be solid as in case of bones and cartilages and fluid as in case of blood.

Functions:

1. It serves the function of binding and joining one tissue to other i.e. connecting bones to each other, muscles to bones, etc.
2. It forms a supporting framework of bones and cartilages for the body.
3. It forms a protective sheath and packing material around various organs separating them so'that they do not interfere in each other's activities, carrying material from one part of the body to another.

Connective Tissue:

Types:

In animals there are five types of connective tissue:

1) Areolar tissue
2) Dense regular connective tissue
3) Adipose tissue
4) Skeletal tissue
5) Fluid connective tissue

1) *Areolar tissue*:

It is also called as loose connective tissue. It is a loose and cellular connective tissue. It is most widely distributed in the body. It consists of transparent, jelly like sticky matrix containing numerous fibres and cells and mucin. Its matrix consists of two kinds of fibres.

a) *White collagen fibres*: They are made up of a protein, collagen which changes into gelatin on boiling in water.

b) Yellow elastic fibres: They are made up of a protein elastin. Collagen fibres provide flexibility and strength and elastic fibres provide elasticity. Several kinds of irregular cells for example fibroblasts and macrophages are present in it.

Occurence:

It is simple and most widely distributed connective tissue. It joins skin to muscles, fills spaces inside organs and is found around muscles, blood vessels and nerves.

Functions:

(i) It is a supporting and packing tissue between organs lying in the body cavity. Matrix of this tissue is important in diffusion of oxygen and nutrients from small blood vessels. (ii) It helps in repair of tissues after an injury.

(iii) It fixes skin to underlying muscles.

***2) Dense regular connective tissue**:*

It is a fibrous connective tissue. It is characterised by ordered and densely packed collection of fibres and cells. Fibres are loose and very elastic in nature. It is the principal component of tendons and ligaments.

1. *Tendons*: They are cord like, strong, inelastic structures that joins muscles to bones. A tendon is a bundle of white collagen fibres bound together by aerolar tissue. It has great strength but its flexibility is limited.

2. *Ligaments*: They are elastic structures which connect bones to bones. A ligament is highly elastic and has great strength but contains very little matrix. In ligament, some elastic and many collagen fibres are bound together by areolar connective tissue. Fibroblasts are irregularly arranged.

3) *Adipose tissue*:-

It is an aggregation of fat cells or adipocytes. Each fat cell is rounded or oval and contains a large droplet of fat that almost fills it. The fat cells are arranged in lobules separated by partitions of collagen and elastin fibres. These partitions carry blood vessels.

Occurence:

It is abundant below the skin, between the internal organs for example around the kidneys.

Functions:

1. It serves as a fat reservoir.
2. It provides shape to the limbs and the body.
3. It keeps visceral organs in position. It forms shock absorbing cushions around kidneys and eyeballs.
4. It acts as an insulator.

4) Skeletal Tissue:

The skeletal or supporting tissue includes cartilage and bone which form the endoskeleton of vertebrate body.

1. *Cartilage*:

It is a specialised connective tissue which is compact and less vascular. It has widely spaced cells. Its matrix is composed of proteins and is slightly hardened by calcium salts. Its matrix is produced and maintained by chondrocytes. Matrix is solid, cheese like and firm but also somewhat elastic. This accounts for its flexible nature. Matrix of cartilage have a delicate network of collagen fibres and living cells, chondrocytes. Chondrocytes are present in fluid filled spaces known as lacunae. Blood vessels are absent in matrix. Chondrocytes help in internal growth of cartilage by multiplying. Thus cartilage is capable of continued and rapid growth.

Occurence:

It is located in ear pinna, nose tip, epiglottis, intervertebral discs, end of long bones, lower ends of ribs and rings of trachea.

Functions:

It provides support and flexibility to the body parts. It smoothens surface at joints.

2) *Bone*

Nature:- Bone is a very strong and non-flexible tissue. Like cartilage, bone is a specialised connective tissue. It is porous, highly vascular, mineralised, hard and rigid. Its matrix is made up of proteins e.g. osteonectin, osteocalcin, proteoglycan and collagen). Matrix of bone is heavily coated with salts of calciurn and magnesium such as phosphates and carbonates of calcium and magnesium (e.g.
Hydroxyapatite). These minerals are responsible for the hardness of the bone. The matrix of bone is in the form of thin concerntric rings, called lamellae. Bone cells, called osteoblasts or osteocytes, are present between the lamellae in fluid-filled spaces called lacunae. All lacunae of the bone communicate with each other by network of fine canals, called canaliculi. Each canaliculus is filled with delicate
cytoplasmic process of the bone cell. Through canalculi each bone cell of each lacuna receives food and oxygen and eliminates waste.

Functions:-Bone forms endoskeleton of human beings and other vertebrates except the sharks. It serves the following

Functions:

1. It provides shape to the body.
2. It provides skeletal support to body.
3. It protects vital body organs such as brain, lungs, etc.
4. It serves as storage site of calcium and phosphate.
5. It anchors the muscles.

Fluid Connective Tissue (Vascular Tissue):

It links the different parts of the body and maintains continuity in the body. It includes blood and lymph.

Blood:- It a fluid connective tissue. It is reddish coloured due to presence of a pigment called as haemoglobin. This blood carries various functions in our body.

i) Circulation of blood is responsible for transportation of soluble digested food from small intestines to various parts of body. Blood also carries glucose from liver to muscles,

ii) Blood carries soluble excretory materials such as urea to organs of excretion.

iii) Blood carries hormones from endocrine glands to target parts

iv) Circulation of blood helps to maintain constant body temperature by

distributing excessive heat from deeply seated organs.

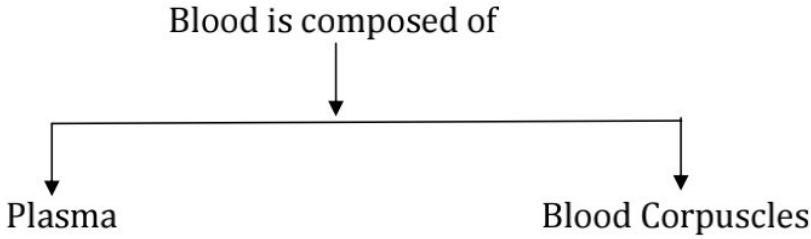
v) Blood transports O_2 from lungs to all parts of body.

vi) Blood carries CO_2 produced by the tissues to the lungs for breathing out.

vii) WBC of blood acts as soldiers of body by killing bacteria and other germs.

viii) It acts as a buffer and maintains a constant pH which maintains the concentration of solute potential of blood i.e. electrolytes.

Composition of blood



Plasma:-It is liquid part of blood in which different blood cells are present. It is straw coloured or can be colourless. It contains major portion of water (90%) and also (10%) of organic / inorganic substances. The different organic substances that are present in it are urea, amino acids, proteins, hormones and the different inorganic substance present in it are sulphates, phosphates, magnesium. Besides, the organic and inorganic substances, it also contains a blood clotting protein called fibrinogen and also contains Anti-coagulant called heparin. If fibrinogen is removed from blood, it results in the formation of serum in plasma. (Serum- A blood plasma from which blood clotting protein is removed).

Different types of blood cells:

i) RBC ii) WBC

iii) Platelets

RBC's : These are also called erythrocytes. These are small, round, biconcave, disc-like structures that are thinnest at the centre. The real colour of RBC is pale yellow but appear red due to presence of haemoglobin. These are 7-8 um in diameter and are denucleated (to transport more O_2). In males, the number of RBC's is 5.5 m/cm^3 and females 4-4.5m/cm^3. RBC have a life span of 120 days and main constituent of RBC is haemoglobin. Due to less presence of RBC's a disease called anaemia is caused which causes breathlessness. If there is more amount of haemoglobin present in blood, it leads to abnormal growth of RBC and thus leads to cancer called polycythemia. Formation of RBC is called

erythropoiesis and is formed in red bone marrow. These RBC's get degraded in liver. Shrinking of RBC's in liver is called erytopis. The content of haemoglobin:

In males is 15.5 +/- 2.5 gm/decileter

In females it is 14.0 +/- 2.5gm/decileter

In children it is 11.0 +/- 2.5 gm/decileter (4 -12 years).

WBC's:-These are also called leucocytes. These are colourless and amoeboid shaped/ irregular). These are large in size than RBC's and are fewer in number. The number of WBC's in males and females is same 5000mm^3. These are nucleated i.e. they have nucleus. There are various types of WBC's like monocytes. Basophills, neutrophills, eosinophills, lymphocytes. WBC's are of two types: Phagocytes and Immunocytes.

Immunocytes: These produce antibodies and are involved in immune response. They include lymphocytes.

Phagocytes: These are capable of phagocytoses and they carry out the function of body defense by engulfing bacteria and other foreign substances. Phagocytes are of two types:

Granular and agranular.

Granular WBC's: These have granular cytoplasm and lobed nucleus. These are of three types basophills, neutrophills, eosinophills.

Agranular WBC's: These have smooth cytoplasm and lobed nucleus e.g. monocytes, lymphocytes. WBC's don't have a particular life span because they are of different types. So, their life span varies like lymphocytes. They have a life span of almost 3-4 days. They provide immunity to body when foreign material enters our body i.e. antigen and our body responses to it. The WBC's engulf it and form a protein called antibodies. These are also called soldiers of our body.

Most WBC are amoeboid and can throw out pseudopodia by which they can squeeze out through the walls of capillaries into tissues. This process is called diapedesis. If more no. of WBC are present in body it will lead to a disease (cancer) called leukaemia.

If less no. of WBC's is present, it will lead to a.disease called leucopoenia. These are formed in white and yellow bone marrow.

Blood Platelets: These are also called thrombocytes. These are small, spherical structures numbering about 4,00,000/mm^3 . These have life span of 2-3 days and are denucleated. It contains a blood clotting protein called thrombin. The function of B.P. is to form a solid plug at the time of injury

which prevents further blood loss.

Lymphatic system:

Lymph: It is light yellow colour, mobile, fluid connective tissue which drains into lymphatic capillaries from inter cellular spaces. Its composition is similar to that of blood except that RBC's and some blood proteins are absent in it. WBC's are found in abundance.

Functions of Lymph

1) Lymph absorbs some of the fluid from digestive tract. It passes proteins to tissues. It carries digested fat.
2) It drains excess fluid from extra cellular spaces back in the blood.
3) It protects the body by killing germs.
4) It carries carbon dioxide and nitrogenous waste materials from tissues to blood.